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**UTILITY PATENT APPLICATION TRANSMITTAL
(Small Entity)***(Only for new nonprovisional applications under 37 CFR 1.53(b))*Docket No.
AVID.13-2Total Pages in this Submission
3**TO THE ASSISTANT COMMISSIONER FOR PATENTS****Box Patent Application
Washington, D.C. 20231**

Transmitted herewith for filing under 35 U.S.C. 111(a) and 37 C.F.R. 1.53(b) is a new utility patent application for an invention entitled:

CABLE FEED FOR A MECHANICAL BALL BEARING DISC BRAKE

and invented by:

**WAYNE R. LUMPKIN
MICHAEL T. MAYBERRY**jc931 U.S. PTO
09/685284**PRIORITY CLAIM**

I hereby claim the benefit under 35 USC § 119(e) of any United States provisional application(s) listed below:

Application Number: 60/195,560

Filing Date: (mo/day/yr) 04/06/00

Enclosed are:

Application Elements

1. ☒ Filing fee as calculated and transmitted as described below
2. ☒ Specification having 28 pages and including the following:
 - a. ☒ Descriptive Title of the Invention
 - b. ☒ Cross References to Related Applications *(if applicable)*
 - c. ☐ Statement Regarding Federally-sponsored Research/Development *(if applicable)*
 - d. ☐ Reference to Microfiche Appendix *(if applicable)*
 - e. ☒ Background of the Invention
 - f. ☒ Brief Summary of the Invention
 - g. ☒ Brief Description of the Drawings *(if drawings filed)*
 - h. ☒ Detailed Description
 - i. ☒ Claim(s) as Classified Below
 - j. ☒ Abstract of the Disclosure

UTILITY PATENT APPLICATION TRANSMITTAL (Small Entity)

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Application Elements (Continued)

3. ☒ Drawing(s) (when necessary as prescribed by 35 USC 113)
- a. ☐ Formal b. ☒ Informal Number of Sheets 25
4. ☒ Oath or Declaration
- a. ☒ Newly executed (original or copy) ☐ Unexecuted
- b. ☐ Copy from a prior application (37 CFR 1.63(d)) (for continuation/divisional application only)
- c. ☒ With Power of Attorney ☐ Without Power of Attorney
- d. ☐ DELETION OF INVENTOR(S)
Signed statement attached deleting inventor(s) named in the prior application,
see 37 C.F.R. 1.63(d)(2) and 1.33(b).
5. ☐ Incorporation By Reference (usable if Box 4b is checked)
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under
Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby
incorporated by reference therein.
6. ☐ Computer Program in Microfiche
7. ☐ Genetic Sequence Submission (if applicable, all must be included)
- a. ☐ Paper Copy
- b. ☐ Computer Readable Copy
- c. ☐ Statement Verifying Identical Paper and Computer Readable Copy

Accompanying Application Parts

8. ☒ Assignment Papers (cover sheet & documents)
9. ☐ 37 CFR 3.73(b) Statement (when there is an assignee)
10. ☐ English Translation Document (if applicable)
11. ☐ Information Disclosure Statement/PTO-1449 ☐ Copies of IDS Citations
12. ☐ Preliminary Amendment
13. ☒ Acknowledgment postcard
14. ☒ Certificate of Mailing
- ☐ First Class ☒ Express Mail (Specify Label No.): EL587742909US

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Accompanying Application Parts (Continued)

15. ☐ Certified Copy of Priority Document(s) (if foreign priority is claimed)
16. ☒ Small Entity Statement(s) - Specify Number of Statements Submitted: 1
17. ☐ Additional Enclosures (please identify below):


Fee Calculation and Transmittal

CLAIMS AS FILED

For	#Filed	#Allowed	#Extra	Rate	Fee
Total Claims	18	- 20 =	0	x \$9.00	\$0.00
Indep. Claims	3	- 3 =	0	x \$39.00	\$0.00
Multiple Dependent Claims (check if applicable) <input type="checkbox"/>					\$0.00
BASIC FEE					\$355.00
OTHER FEE (specify purpose) <u>Assignment Recordation Fee</u>					\$40.00
TOTAL FILING FEE					\$395.00

- ☒ A check in the amount of \$395.00 to cover the filing fee is enclosed.
- ☒ The Commissioner is hereby authorized to charge and credit Deposit Account No. 19-5117 as described below. A duplicate copy of this sheet is enclosed.
- ☐ Charge the amount of _____ as filing fee.
- ☒ Credit any overpayment.
- ☐ Charge any additional filing fees required under 37 C.F.R. 1.16 and 1.17.
- ☐ Charge the issue fee set in 37 C.F.R. 1.18 at the mailing of the Notice of Allowance, pursuant to 37 C.F.R. 1.311(b).

Dated: October 10, 2000



Signature

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cc: Wayne R. Lumpkin

**VERIFIED STATEMENT CLAIMING SMALL ENTITY STATUS
(37 CFR 1.9(f) & 1.27(c))--SMALL BUSINESS CONCERN**

Express Mail Label No. EL587742909US

Docket No. AVID.13-2

Applicant or Patentee: LUMPKIN *et al.*
Serial or Patent No.: Express Mail Label No. EL587742909US
Filed or Issued:
Title: Cable Feed for a Mechanical Ball Bearing Disc Brake

I hereby declare that I am

- ☐ the owner of the small business concern identified below.
☒ an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF SMALL BUSINESS CONCERN: AVID, L.L.C.
ADDRESS OF SMALL BUSINESS: 2875 W. Oxford Avenue, #7
Englewood, Colorado 80110

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 37 CFR 1.9(d), for purposes of paying reduced fees to the United States Patent and Trademark Office, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention described in:

- ☒ the specification filed herewith with title as listed above.
☐ the application identified above.
☐ the patent identified above.

If the rights held by the above-identified small business concern are not exclusive, each individual, concern or organization having rights in the invention must file separate verified statements averring to their status as small entities, and no rights to the invention are held by any person, other than the inventor, who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person made the invention, or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d), or a nonprofit organization under 37 CFR 1.9(e).

- Each person, concern or organization having any rights in the invention is listed below:
☒ no such person, concern or organization exists.
☐ each such person, concern or organization is listed below.

Full Name and Address: ☐ Individual
☐ Small Business Concern
☐ Non-profit Organization

Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their small entity status (37 CFR 1.27).

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 USC §1001 and that such willful false statements may jeopardize the validity of the application, any patent issued thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING: Wayne R. Lumpkin
TITLE OF PERSON IF OTHER THAN OWNER: President
ADDRESS OF PERSON SIGNING: 2875 W. Oxford Avenue, #7
Englewood, Colorado 80110

SIGNATURE

DATE: 9-12-00

CABLE FEED FOR A MECHANICAL BALL BEARING DISC BRAKE

5 RELATED APPLICATIONS

This application claims priority from United States Provisional Patent Application Serial No.60/195,560, filed April 6, 2000, entitled "Mechanical Disc Brake Caliper", the contents of which are incorporated herein in their entirety.

10 TECHNICAL FIELD

The present invention is directed toward mechanical disc brakes, and more particularly toward a cable feed apparatus and method for connecting a cable to a mechanical disc brake.

15 BACKGROUND ART

Disc brakes are being included on more and more bicycles as consumers are ever increasingly demonstrating a preference for disc brakes over conventional rim brakes such as caliper brakes, cantilever brakes and side pull cantilever brakes. While both mechanical and hydraulic disc brakes have been available for bicycles for many years, only recently have there been advances in mechanical disc brake caliper design that have made mechanical disc brakes sufficiently lightweight, powerful, reliable and inexpensive to satisfy consumer preferences. While more efficient and powerful cable actuated mechanical disc brakes are evolving, to date manufacturers of mechanical disc brakes have not adequately addressed providing an efficient cable feed that minimizes friction on the cable as well as cable fatigue.

25 One known cable feed structure for a cable actuated mechanical disc brake caliper provides a cable guide on the housing which functions at a cable housing stop and guide to direct cable to an actuating lever of the cable actuated mechanical disc brake caliper. The cable guide of this cable actuated mechanical disc brake is pivotably attached to the caliper housing. While this pivotal attachment is intended to direct the cable on a straight line
30 between the guide and the pivoting actuating arm of the caliper brake, it presents a serious

problem because of the possibility of grit or debris causing the pivotal attachment to seize in a pivoted position that introduces a bend to the cable. With time, such a bend can introduce fatigue and possible failure to the cable, with disastrous results to the rider.

There remains a need to provide a cable feed for a cable actuated mechanical disc brake caliper which minimizes or eliminates bends in the cable as it is fed and attached to an actuating arm of the caliper to minimize fatigue as well as friction on the cable which can degrade the performance of the brake.

The present invention is directed toward overcoming one or more of the problems discussed above.

SUMMARY OF THE INVENTION

A cable actuated bicycle mechanical disc brake caliper includes caliper housing and a cable guide rigidly fixed to the housing with the cable guide having a cable receiving bore extending along a guide axis for axially receiving a cable. A lever arm is pivotably attached to the caliper housing for pivoting about a pivot axis. The lever arm is operatively associated with a brake pad to move the brake pad between a retracted and an extended position as the lever arm is pivoted in a first direction from a non-actuated position to a fully actuated position. The lever arm includes a cable clamp spaced from the pivotal attachment for fixedly attaching a cable to the lever arm in a select orientation relative to the lever arm at an attachment point. The attachment point is essentially coincident with the guide axis with the cable arm in the fully actuated position.

A second aspect of the present invention is a cable actuated mechanical disc brake caliper including a caliper housing having a cable guide rigidly fixed to the housing with the cable guide having a cable receiving bore extending along a guide axis for axially receiving a cable. A lever arm is pivotably attached to the caliper housing for pivoting about a pivot axis with the lever arm being operatively associated with a brake pad to move the brake pad between a retracted and an extended position as the lever arm is pivoted in a first direction from a non-actuated position to a fully actuated position. The lever arm includes a cable clamp circumferentially spaced from the pivotal attachment for fixedly attaching a cable to

the lever arm in a select orientation relative to the lever arm at an attachment point. A guide surface which is curved about the pivot axis has a first portion attached to the lever arm with the attachment point essentially coincident therewith. A second portion is circumferentially spaced from the first portion and the second portion is essentially tangent to the guide axis with the lever arm in the non-actuated position. The curved surface may be concentric about the pivot axis. Alternatively, the curved surface is eccentric about the pivot axis and the radius of the curved surface may either increase or decrease between the first and second portions. The cable clamp preferably clamps along an axis normal to the pivot axis. The curved surface is preferably formed by a horn attached to the lever arm at the first portion with the second portion being a free end of the horn.

Yet another aspect of the present invention is a method of directing a cable to a lever arm of a cable actuated mechanical disc brake caliper wherein the lever arm is pivotably attached to a housing of the brake caliper for pivoting about a pivot axis. The lever arm is operatively associated with a brake pad to move the brake pad between a retracted and an extended position as the lever arm is pivoted in a first direction from a non-actuated position to a fully actuated position. The method includes providing a cable guide rigidly attached to the caliper defining a cable guide axis a select radial distance from the pivot axis. A cable is fed through the cable guide and attached to the lever arm at an attachment point about the select radial distance from the pivot axis. The cable is maintained essentially tangent to the guide axis as the lever is pivoted between the non-actuated and the actuated positions.

The cable guide structure and method of attaching a cable to a lever arm of a cable actuated mechanical disc brake in accordance with the present invention provides for efficient attachment of the cable to the lever arm which minimizes friction on the cable to improve brake performance. The method and cable feed structure further eliminate the possibility of any bends or kinks in the cable which could fatigue and possibly lead to failure of the cable. The structure and method are accomplished without moving parts, which both simplifies assembly and reduces the cost of the mechanically actuated disc brake caliper. Furthermore, elimination of moving parts provides for a highly reliable cable actuated mechanical disc brake caliper.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view showing the mechanical disc brake caliper of the present invention mounted to a fork of a bicycle in operative engagement with a brake disc;

Fig. 2 is the mechanical disc brake caliper of Fig. 1 including an adaptor for mounting to a frame with different mounts;

Fig. 3A is a front elevation view of the mechanical disc brake caliper of Fig. 1 including a floating cable stop;

Fig. 3B is identical to Fig. 3A except it further includes an alternate embodiment of the floating cable stop;

Fig. 3C is a cross-section of the floating cable stop taken along line 3C-3C of Fig. 3A;

Fig. 4A is an exploded perspective view of the mechanical disc brake caliper of Fig. 1;

Fig. 4B is an exploded perspective view from a perspective rotated 180° from that of Fig. 4A;

Fig. 4C is a bottom perspective view of a clamp plate in accordance with the present invention;

Fig. 5 is a cross-section of the mechanical disc brake caliper taken along line 5-5 of Fig. 3A with the brake pads retracted;

Fig. 6 is the same as Fig. 5 only with the brake pads extended using the pad wear compensation apparatus;

Fig. 7 is the same as Fig. 5 only it illustrates the brake pads advanced by the drive mechanism into contact with a disc;

Fig. 8 is a cross-section of the mechanical disc brake caliper taken along line 8-8 of Fig. 3A;

Fig. 9 is a cross-section of the mechanical disc brake caliper taken along line 9-9 of Fig. 8;

Fig. 10 is a right side view of the mechanical disc brake caliper with the lever arm in an at rest position;

Fig. 11 is a right side elevation view of the mechanical disc brake caliper with the lever arm actuated to the braking position;

Fig. 12 is a cross-section of the cable feed taken along line 12-12 of Fig. 10;

Fig. 13 is a front exploded view of the cable feed;

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Fig. 14 is an exploded view of the outer indexing knob assembly;

Fig. 15 is an exploded view of the inner indexing knob assembly;

Fig. 16A is a perspective view of the mechanical disc brake caliper with a portion of the housing cut away to reveal the pad receiving cavity;

10 Fig. 16B is a sectional view of the mechanical disc brake caliper taken along line 16B-16B of Fig. 10;

Fig. 17A-C are alternate embodiments of the backing plates of the brake pad assemblies;

Fig. 18 is identical to Fig. 16, only showing the pad assembly installed with the pad assembly recess;

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Fig. 19 is a perspective view of the outer knob;

Fig. 20 is a perspective view of the outer knob from a perspective rotated 180° from that of Fig. 19;

Fig. 21 is a perspective view of the inner knob;

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Fig. 22 is a perspective view of the inner knob taken from a perspective rotated 180° from that of Fig. 21;

Fig. 23 is a front view of the lever arm illustrating the progressive, eccentric shape of the cable guide surface;

Fig. 24 is a front view of the lever arm illustrating the constant, concentric shape of the cable guide surface;

25

Fig. 25 is a perspective view of a ball retainer;

Fig. 26 is a sectional view of a ball retainer taken along line 26-26 of Fig. 25 with a ball engaged therein;

Fig. 27 is a perspective view of an alternate embodiment of a ball retainer;

Fig. 28 is a sectional view taken along line 28-28 of Fig. 27 with a ball engaged by the retainer; and

Fig. 29 is a plan view of an alternate embodiment of ramped grooves in a fixed cam.

5 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

10 A mechanical disc brake caliper 10 in accordance with the present invention is shown in Fig. 1 mounted to a frame or, more particularly, a front fork 12 of a bicycle in operative engagement with a disc 14. As shown in Figs. 1-3, the caliper 10 is mounted to a front fork 12 for use with a front wheel. For use with the rear wheel, the caliper is typically mounted to the seat stay, chain stay, drop out plate, after market adapter or the like. The disc 14 in turn is rigidly mounted to the hub of a wheel assembly by the bolts 16. For the sake of clarity, the bicycle wheel and hub are not shown.

15 The mechanical disc brake caliper consists of a caliper housing 18 having a pair of mounting feet 20, 22 extending therefrom for attachment to a corresponding pair of internally threaded attachment bosses 24, 26 which extend from the front fork 12. A pair of mounting bolts 28 secure the mounting feet 20, 22 to the attachment bosses 24, 26. The mounting feet preferably include elongate slots 27 (see Fig. 5) receiving the mounting bolts 28 and complimentary pairs of concave/convex washers 30 to provide for adjustable attachment of the mechanical disc brake caliper to a bicycle frame. Such an attachment structure is described in detail in applicant Wayne Lumpkin's, co-pending Patent Application Serial No. 20 09/383,121, the disclosure of which is hereby incorporated in its entirety herein.

25 As seen in Fig. 1, a lever arm 32 is pivotably attached at a first end 34 to the caliper housing 18. A second end of the lever arm 36 has a cable clamp 38 which secures an end of the cable 40. The cable 40 is directed through a cable feed 42 attached to the caliper housing 18 with a cable housing 44 abutting the cable feed 42. While the operation of the mechanical disc brake will be described in considerably greater detail below, it is useful at the outset to understand that the mechanical disc brake caliper is actuated by tension being applied to an opposite end of the cable 40 by a cable actuator such as a conventional cable brake lever (not shown) and this tension causes the lever arm 32 to pivot about pivot axis 46 in the direction

of arrow 48 so that the second end of the lever arm 36 is drawn toward the cable guide 42 to advance a brake pad into contact with the disc 14 by a rotary to linear linkage between the first end 34 of the lever arm 32 and the brake pad.

Fig. 2 shows the mechanical disc brake caliper 10 mounted to a front fork 12' having internally threaded attachment bosses 24' and 26' with an axis parallel to the axis of rotation of the disc 14. The mechanical disc brake caliper 10' is in all manner identical to the mechanical disc brake 10 described above with regard to Fig. 1. For simplicity, all unnecessary corresponding reference numbers have been omitted. An adapter bracket 60 is fastened by a pair of bolts 62 to the attachment bosses 24', 26' and includes a pair of internally threaded receptor bores 64 that enable the caliper housing 18 to be attached to the front fork 12' in an identical position relative to the disc 14 described above with respect to Fig. 1. Thus, the adapter bracket provides an equivalent mounting surface to that provided by the attachment bases 24, 26, as shown in Fig. 1.

Fig. 3A is a front elevation view of the mechanical disc brake caliper 10 mounted to a bicycle frame 12 as illustrated in Fig. 1. Fig. 3 differs from Fig. 1 by the inclusion of the floating cable stop 70, which will be described in greater detail below.

The mechanical disc brake caliper 10 is shown in an exploded perspective view in Fig. 4A. Fig 4B is identical to Fig. 4A, only the perspective is rotated 180°. First and second brake pad assemblies 72, 74 consist of mirror image backing plates 76, 78 each having a trailing surface 80 including a post receiving receptacle 81 and a leading surface 82 to which a brake pad 84 is permanently adhered. When the mechanical disc brake caliper is operatively associated with a disc 14, the disc 14 resides between the pads 84 of the first and second brake pad assembly 72, 74 which are held in place in part by a pad retention clip 85 in a manner which will be described in greater detail below.

As oriented in Fig. 4A, the second brake pad assembly 74 is also known as the back or inboard brake pad assembly. A pad wear compensator 73 for the inboard pad assembly includes inboard pressure foot 86, which as discussed below, functions as an indicator. The inboard brake pad assembly 74 is attached to the inboard pressure foot 86 by means of a washer-shaped magnet 88 which is adhered to a cooperatively shaped receptacle 90 in the

leading surface 92 of the inboard pressure foot 86. An axial post 94 extends through the hole in the washer-shaped magnet 88 and protrudes beyond the leading surface 92 to engage the post receiving receptacle 81 in the trailing surface of the backing plate. A trailing portion or indicator dog 96 having a rectangular cross-section extends from a trailing surface of the inboard pressure foot 86 along the same axis of the axial post 94. The edge of the inboard pressure foot 86 is threaded as indicated at 100 between the leading surface 92 and the trailing surface 98. The threads 100 are sized to threadably engage complimentary threads 102 in the inner diameter of an inside cylinder 104 of the caliper housing 18 (see Figs. 4B and 5). This threaded engagement allows for linear advancement of the pressure foot as it is rotated. An inboard pad advancement adjustment knob 106 has knurled edge 108, an axial orifice or hole 110. The axle hole is configured snugly, axially, slidably receive the indicator dog 96 of the inboard pressure foot 86 but to prevent rotation between the pressure foot and the adjustment knob. A plurality of axially inward extending legs 112 having radially outwardly extending barbs 114 at their distal ends. An inside indexing spring clip 116 has a plurality of radially extending legs 118 sized to be received between the axially inwardly extending legs 112 of the inner knob 106. The inside indexing spring clip 116 further includes axially inwardly extending bars 122 having radially outward extending detents 123 at their distal ends. As best seen in Fig. 5, the dog 96 extends through the hole 126 in the inside indexing spring clip 116 and into the axial hole 110 in the inner knob 106. The barbs 114 engage an inner edge of an inward extending annular flange 125 to lock the inner knob 106 against axial movement. The detents 123 in turn engage equally circumferentially spaced indexing knurls 127 in the inner surface of the flange 125. As will be described below, the complimentary detents and indexing knurls provide a tactile indication of pad adjustment as the inboard knob 106 is rotated.

With continued reference to Figs. 4A, 4B and 5, the caliper housing 18 also includes an outboard cylinder 128 which is coaxial with the inboard cylinder 104. The bulk of the remaining components of the mechanical disc brake caliper 10 reside within the outboard cylinder 128. The outboard cylinder 128 has an annular groove 130 (see Fig. 4B) in its inner diameter sized to receive the hoop-shaped polymer dust seal 132. Outboard pressure foot 134

has an identical leading surface to the leading surface 92 of the inboard pressure foot 86 and identical reference numbers are used in Fig. 4B. Washer-shaped magnet 88', which is identical to washer-shaped magnet 88, is adhered within the cooperative shaped receptacle 90 of the leading surface 92 of the outer pressure foot 134. The outside or first brake pad assembly 72 is attached by the washer-shaped magnet 88' to the leading surface of the outer pressure foot 134. The trailing surface 136 has an axially extending post 138 having an annular groove 140 in its sidewall near the distal end. In the distal end is an axial cup 142. Split ring 144 is sized to be received in the annular groove 140. Ball bearing 146 is sized to be received in and to extend axially from the axial cup 142.

An indicator foot screw 148 has a head 149 with a leading surface 150 which abuts the ball bearing 146. Behind the head 149 is a shaft 152 which is threaded adjacent to the head 149 as indicated at 154. The trailing end of the shaft 152 has a pair of flats 156 (one shown in Fig. 4A) on opposite sides. The indicator foot screw 148 is an integral part of a pad wear compensator 153 for the outboard brake pad assembly.

Drive cam 158 has an enlarged diameter base 160 having a plurality of equally spaced curved, ramped grooves 162 in its trailing surface. The preferred embodiment has three ramped grooves 162 spaced at 120°. A cylindrical shaft 164 extends rearward of the enlarged diameter base 160 and has an axial bore 166 which extends axially through the drive cam 158. As best viewed in Fig. 5, the axial bore includes a threaded inner diameter portion 168 which threadably engages the threaded portion 154 of the foot screw 148 with the shaft 152 extending rearwardly from the axial bore 166. Further referring to Fig. 5, an inwardly extending flange 170 acts as a stop against a rearward portion of the head 149. The distal end of the outside cylindrical shaft 164 is threaded at 172 and adjacent the treaded portion 172 is a hex portion 174. One of three ball bearings 176 resides in each ramped groove 162. The outer diameter of the enlarged diameter base 160 is sized to fit snugly within the inner diameter of the outside cylinder 128 and have a sealing relationship with the dust seal 132 as best seen in Figs. 5 and 7.

Fixed cam 178 has a generally cylindrical body 180 with a constant inner diameter orifice 182. An intermediate step 184 has a spring tension limiting boss 186 which extends

axially onto the cylindrical body 180. A leading step 188 has an outer diameter greater than that of the intermediate step 184 and an enlarged outside diameter annular flange 190 rises from the leading step 188 adjacent the intermediate step 184. A locking boss 192 extends toward the leading surface 193 collinearly with the spring tension limiting boss 186 at a height matching that of the enlarged outer diameter annular flange 190. The locking boss 192 is sized to key into a receiving slot 194 in the inner diameter of the outside cylinder 128 to lock the fixed cam 178 against axial rotation (see Fig. 4A). In addition, the leading surface of the enlarged outer diameter annular flange 190 abuts a step 196 in the inner diameter of the outside cylinder 128 to halt axial insertion of the fixed cam 178 into the outside cylinder 128 from the opened end as viewed in Fig. 4A. The engaged relationship can best be seen in Fig. 5. The leading surface 193 of the fixed cam 178 is best viewed in Fig. 4B. The leading surface has a plurality of equally circumferentially spaced ramped grooves corresponding to the ramped grooves of the drive cam 158. Fig. 4B shows three ramped grooves 200 spaced at 120° which correspond to the ramped grooves 162 of the drive cam 158, only with the ramps extending circumferentially in opposite directions when aligned as shown in Figs. 4A, 4B and 5-7. A ball bearing 176 resides between each ramped groove pair 162, 200 as best viewed in Figs. 5-7. Referring to Fig. 5, with balls residing in the grooves 162, 200, the grooves and ball bearings act as an angular contact bearing which is able to accommodate axial loads on the drive cam exerted by the lever arm 32. In addition, the ramped grooves self-center the drive cam shaft 164 within the inner diameter 182 of the fixed cam 178 with the drive cam under an axial load. This feature eliminates the need for an optional split bushing (not shown) being press fit in the inner diameter 182 of the fixed cam 178. It further eliminates friction between the drive cam shaft 164 and fixed cam 178. It further reduces needs for tight tolerances between the drive cam shaft 164 and fixed cam 178, thus eliminating the need for costly centerless grinding of the drive cam shaft and reaming of the fixed cam bore 182. These combined advantages significantly improve performance and minimize parts cost and assembly complexity and attendant cost.

When the fixed cam is seated within the outside cylinder 128 as described above and as viewed in Fig. 5, it is locked against axial movement by locking ring 204 which has a

threaded outer diameter 206 and evenly spaced engagement slots 208 in the inner diameter 210. The inner diameter is sized to snugly receive the intermediate step 184 of the fixed cam 178 and the engagement slots 208 allow for engagement by a special turning tool (not shown) so that the threaded outer diameter 206 can be brought into threaded engagement with corresponding threads 212 in the inner diameter of the outside cylinder 128.

A generally washer-shaped spring tension biasing plate 220 has an inner diameter which snugly axially receives the intermediate step 184 of the fixed cam 178 and includes a spring tension limiting slot 222 which receives the spring tension limiting boss 186. A cut in the outer diameter of the spring tension biasing plate forms a stop surface 224. Near the stop surface 224 is a hole 226. Return spring 228 has a pair of axially extending ends 230, 232. The inner diameter of the return spring 228 is large enough to axially receive the fixed cam 178 and the shaft 164 of the drive cam 158 as best viewed in Fig. 5. The axially extending end 230 is received in the hole 226 of the spring tension biasing plate 220 (see Fig. 5). A dust seal 234 defines an annular cover 236 for the return spring 228 as seen in Figs. 4B and Figs. 5-7. The inner diameter of the trailing orifice 238 is sized to receive and have a sealing relationship with the outer diameter of a leading flange 240 of the lever arm 32. A hole 242 in the trailing surface of the cover 236 receives the axially extending rod 232. The axially extending rod 232 in turn is received in the hole 244 near the first end 34 of the lever arm 32.

A hex orifice 246 near the first end 34 of the lever 32 axially receives the hex portion 174 of the cylindrical shaft 164 of the drive cam 158 with a hex inner diameter washer 248 therebetween to radially fix the lever arm 32 to the drive cam 158. Washer 252 abuts the trailing surface 254 and is sandwiched by a larger outer diameter washer 256. The larger outer diameter washer 256 has a number of equally circumferentially spaced indexing knurls 258 in its outer diameter. The washers 252, 256 and the lever arm 32 are axially secured to the cylindrical shaft 164 of the drive cam 158 by nut 260 which threadably engages the threaded portion 172 of the cylindrical shaft 164.

An outboard knob 264 has a knurled edge 266 and an orifice or axial hole 268 sized and dimensioned to snugly receive the flats 156 of the trailing end of the foot screw 148

therein, as illustrated in Fig. 5. Referring to Fig. 4B, a plurality of axially inwardly extending legs 270 are equally circumferentially spaced in an inside surface of the outer knob 264. At the distal end of each axially inwardly extending leg 270 is an inwardly protruding barb 272. An outside indexing spring clip 274 has a plurality of axially extending bars 276 each having an inwardly extending detent 278 near its distal end. The axially extending bars 276 are sized to snugly fit between the axially inwardly extending legs 270 of the outboard knob (see Fig. 4A). With the outside indexing spring clip axially engaged with the outer knob 264 in the orientation illustrated in Fig. 4A, the outer knob 264 is axially advanced over the nut 260 and the inwardly protruding barbs 272 lockingly engage the outer diameter edge of the large outer diameter washer 256 to lock the outer knob 264 against axial movement. When attached in this manner, the inwardly extending detents 278 of the outside indexing spring clip engage the indexing knurls 258 of the larger outer diameter washer 256. This can be best seen in detail with reference to Figs. 14 and 5. As will be described further below, the complimentary detents and indexing knurls provide a tactile indication of pad advancement as the outboard knob 264 is rotated.

With reference to Figs. 4A, 12 and 13, the cable feed 42 consists of a mount 284 which is preferably integrally cast with the housing 18. The mount 284 includes an orifice 286 centered along a guide axis 288. A cylindrical housing stop feral 290 has a cylindrical main body 292 having an outer diameter dimensioned to fit freely yet snugly within the orifice 286. A minor boot retention barb 294 extends axially from a leading end of the housing stop feral. A major boot retention barb 296 extends axially from a trailing end of the housing stop feral 290. An annular retention flange 298 extends radially from the main body 292 adjacent to the major boot retention barb 296 and forms a stop which halts axial insertion of the housing stop feral 290 into the orifice 286, as best seen in Fig. 12. Further referring to Fig. 12, the inside of the housing stop feral 290 has a trailing portion having an inner diameter slightly larger than that of a standard cable housing to axially receive the cable housing 44 therein. An annular flange 302 extends inwardly to define a cable guide orifice 304. The inner diameter of the minor boot retention barb 306 is of a size between that of the trailing inner diameter 300 and the cable guide orifice 304.

A hollow minor retention boot 310 is molded of an elastimeric material and at its trailing edge has an inwardly extending annular flange 312 configured to lockingly engage with the minor boot retention barb 294 of the housing stop feral 290. With the housing stop feral 290 inserted in the orifice 286 as illustrated in Fig. 12 and the minor retention boot mounted with the inwardly extending annular flange 312 engaging the minor boot retention barb 294, the housing stop feral is secured against removal from the orifice 286. The minor retention boot has a leading nipple 314 having a leading hole 316 with an inner diameter slightly less than the outer diameter of the standard bicycle brake cable 40. In this manner, the leading nipple forms a wipe seal with the brake cable 40 as seen in Fig. 12.

A hollow major retention boot 320 molded of an elastomeric material has an inwardly extending annular flange 322 sized to lockingly engage with the major boot retention barb 296 on the trailing end of the housing stop feral 290 as best viewed Fig. 12. The trailing end 324 has a tapered inner diameter, which at the extreme trailing end is slightly smaller than the outer diameter of the standard cable housing to form a sealing relationship therewith.

With the lever arm 32 pivotably attached to the housing as illustrated in Figs. 1-3B, 10 and 11, a curved horn 330 defining an axially flat, circumferentially curved cable guide surface 332 extends from a trailing end of the second end 36 of the lever 32. The curved horn 330 curves about the axis of rotation 46 of the lever arm 32. In the preferred embodiment, the curved horn is eccentric about the axis as illustrated schematically in Fig. 23 to provide for progressive increase in power as the lever is actuated by a cable 40. Alternatively, the curved horn can be concentric as shown in Fig. 24 or eccentric and regressive, which though not illustrated, would require the curved horn to have an increasing radius as it extends toward its free end, essentially the opposite of the progressive horn illustrated in Fig. 23.

The cable clamp 38 consists of a screw 334 having a threaded shaft 336 sized to threadably engage an internally threaded bore in the lever arm 32 having an axis normal to the axis of rotation 46. In the preferred embodiment, a clamp plate 338 is secured between the head of the screw 334 and the second end 36 of the lever arm 32. The clamp plate has a tab 340 which is received in a notch 342 defined in the distal end of the lever arm 32 to fix the clamp plate against rotation. A groove 344 is formed in the underside of the clamp plate

adjacent to the notch 342 to receive the cable 40 and has a number of protrusions 345 extending therein to improve the grip of the cable, as illustrated in Fig. 4B.

The curved horn 330 is configured so that with the mechanical disc brake caliper installed on a bike frame as illustrated in Figs. 1-3B, the guide axis 288 is essentially tangent to the free end of the curved horn 330. Essentially tangent means a cable 40 does not have a significant bend when it contacts the cable guide surface 332, but instead has a very gradual transition to the cable guide surface 332 as viewed in Fig. 3. When tension is applied to the cable 40 by a tension actuator such as a conventional bicycle brake lever, the lever arm 32 is drawn toward the cable feed 42. Because of the circumferentially curved cable guide surface 332, the fixed cable clamp and the fixed cable feed 42, no sharp bends are introduced to the cable 40 which might fatigue the cable and lead to premature failure of the cable, which could have disastrous results for a user.

In the embodiment illustrated in Fig. 1, the conventional cable housing extends from the trailing end of the major retention boot 320. An improvement to this conventional brake setup is to provide a floating cable stop 70 mating with the trailing inner diameter 300 of the housing stop ferrule 290 as illustrated in Fig. 3A. The floating cable stop 70 consists of a axially and radially rigid tube 348 made of a suitable material such as a metal like aluminum or stainless steel or an exceptionally rigid thermoplastic. As used herein, axially and radially rigid means the tube 348 has sufficient rigidity that it will not buckle about its lengthwise axis upon application of tension within the normal range of operating tensions applied to the cable 40 which runs within the tube 348. In the preferred embodiment, the tube 348 has a standard cylindrical cross-section (see Fig. 3C), although other cross-sections may be useful or desired.

The outer diameter is preferably essentially the same to that of a standard cable housing 44 so that it can fit into a trailing end of the housing stop ferrule 290 in the same manner as the housing 44 as illustrated in Fig. 12. A connector feral 350 connects the tube 348 to a conventional cable housing 44. The conventional cable housing allows the cable to be axially deflected as may be required to attach the cable to a brake lever. A significant advantage of the floating cable stop 70 is that when it replaces conventional cable housings, it provides a straight path for the cable inside with minimal or no contact with the inner diameter of the

5 tube. Over all but the shortest of lengths, the axially flexible cable housing will buckle about the lengthwise axis under application of even minor tension to the cable within and the resultant compression to the cable housing. Elimination of this buckling further reduces contact of the cable with the inner diameter of the tube and serves to further minimize friction on the cable. The floating cable stop can be deployed wherever there is a straight length of cable, independent of fixed housing stops on the bicycle frame. It also provides a protective barrier for the cable, much like conventional cable housing, but at a lesser weight.

10 In a preferred embodiment illustrated in Fig. 3B, a small length of conventional housing 352 is disposed between the tube 348 and the housing stop feral 290 and is joined to the tube 348 by connector feral 354. The transition housing 352 is advantageous because it will flex in the event of a lateral blow to the tube 348 and thereby minimize the risk of bending of the tube 348 which would detract somewhat from its performance and could even result in undesired buckling of the tube 348. Preferably, the transition housing 352 is of a length that will not buckle under application of operating tensions to the cable 40 but will still provide sufficient axial flexibility to protect the tube 348. Alternatively, if required, the transition housing 352 could be long enough to bend the cable as required to properly cable to the cable feed. Or, an apparatus such as the ROLLAMAJIG, manufactured to Avid, L.L.C., of Englewood, Colorado, U.S. Patent No. 5,624,334, the disclosure of which is hereby incorporated by reference, could be substituted for the transition housing to minimize friction where a bend is required to direct the cable.

20 It should be apparent to those skilled in the art that floating cable stop 70 could be deployed on any cable actuated bicycle component, including cantilevered brakes, caliper brakes, side pull caliper brakes and derailuers.

25 The first and second brake pad assemblies 72, 74 are made to be removable from the caliper housing when a rotor is not operatively associated with the caliper housing between the brake pad assemblies. Referring to Fig. 16A, a retention structure for the first and second brake pad assembly 72, 74 is illustrated. The caliper housing has a cavity 360 configured to receive the disc or rotor 14. The cavity 360 has a mouth 362 at a leading end and includes a pair of opposing recesses 364 (one shown in Fig. 16A). The recesses 364 are configured to

nest the backing plates 76, 78 of the brake pad assemblies 72, 74 on opposite sides of the disc so that the friction pads 84 can be brought into and out of engagement with the disc by an actuating or drive apparatus along an advancement axis 366 in a manner that will be described in greater detail below. At a leading end 368 of pad assembly 72 is a retention tab 370 formed from a pair of extending posts 372, 374 having oppositely extending protrusions 376. Referring to Fig. 16B, within the cavity 360 opposite the mouth 362 is a retention clip cavity 378 opening into the cavity 360. Engagement flanges 380 extend from opposite sidewalls of the retention clip cavity. Pad retention clip 85 is shown in Fig. 16A installed within the retention clip cavity 378. The pad retention clip 85 has a base 382 with a pair of extending sidewalls or legs 384, 386 with a retention detent 388 near the far end of each leg protruding inwardly. Near the base 282 a plurality of retention barbs 390 extend laterally from the sidewalls or legs 384, 386. As illustrated in Fig. 16B, these retention barbs 390 are configured to snap fit with the engagement flanges 380 to lock the pad retention clip 85 within the retention clip cavity 378.

Referring back to Fig. 16A, the pad assembly 72 is installed by grasping the handle 392 and advancing the leading edge 368 into the mouth 362 along the engagement axis 394 and aligning the retention tab 370 with the pad retention clip 85 and further advancing the pad assembly so that the protrusions 370 mate within the retention detents 388. The pad can then be slid into the recess 364 along the advancement axis 366 to seat the pad assembly within the recess 364, as viewed in Fig. 18. When seated in this manner, the walls of the recess 364 secure the pad assembly against movement transverse the advancement axis 366 as a rotating disc is engaged. As best viewed in Fig. 5, it should be appreciated that the axial post 94 of the respective inboard or outside pressure foot 86, 134 is received within the receptacle 81 and the trailing surface 80 of the backing plates to thereby prevent withdrawal of the pad assembly from the mouth 362 of the cavity 360 with the brake pad seated as illustrated in Fig. 18. This connection is also the primary support against withdrawal along the engagement axis as the pad assembly is advanced and withdrawn by the actuation mechanism. The magnet 88 or 88' holds the backing plate in abutment with the respective pressure foot 86, 134 to maintain engagement between the axial post 94 and the receptacle 81. As the brake pads are advanced

along the advancement axis, the cooperating engagement flanges 380 of the pad retention clip and the protrusions 376 of the pad retention tab define a rail facilitating movement forward and backward along the advancement axis. The pad clips can be easily removed from the orifice simply by manually advancing them inward along the advancement axis to bring the receptacle 81 out of engagement with the axial post 94 whereupon the engagement flanges 380 can be snapped out of engagement with the protrusions 376. As shown in Figs. 16A and 16B, the handle 392 has straight edges. To facilitate gripping, the handle may be modified as shown in Figs. 17A-C. In Fig. 17A, the handle has a distal enlargement 395. In Fig. 17B, the handle has grooves 396. In Fig. 17C, the handle has knurls or bumps 397. Other grip enhancing structures will also be apparent to those skilled in the art.

The operation of the mechanical disc brake caliper 10 drive mechanism is best understood with reference to Figs. 1, 5, 6, and 7. Upon actuation of the lever arm 32 by tension applied to the cable 40, the lever arm rotates about the pivot axis 46 in the direction of arrow 48. This in turn causes rotation of the drive cam 158 about this same axis. As the drive cam 158 is rotated, the ball bearings 176 cause the drive cam to advance within the outside cylinder 128 which in turn advances the foot screw 148 which is threadably engaged with the drive cam. The leading surface 150 of the foot screw 148 in turn advances the ball bearing 146 and the outside pressure foot 134 to urge the pad 84 of the outside brake pad assembly 72 into contact with the disc. Further advancement will deflect the disc 14 into contact with pad 84 of the outside brake pad assembly 74, as illustrated in Fig. 7. Upon release of the tension in the cable, the lever arm is biased back to its at rest position by the return spring 228 and the pads are retracted out of contact with the disc to reassume the position illustrated in Fig. 5.

Fig. 10 illustrates that with the lever arm 32 in an at rest position, the cable extends between the cable clamp 38 and the cable feed 42 at a slight angle. With the lever arm 32 rotated about the pivot axis in the direction of arrow 48 so as to bring the pads into engagement with the disc, the lever arm advances axially along the advancement axis with the outer brake pad assembly 72 so that this slight angle is eliminated, as seen in Fig. 11. Thus, it is desirable that the axially flat, circumferentially curved cable guide surface 332 be

wide enough in the axial direction to accommodate the axial movement of the lever arm 32.

As the pads wear, it may be necessary or desirable to advance the pressure feet within the inboard and outboard cylinders to maintain the original spacing between the pads and the disc. The present invention provides a pad wear compensating apparatus that allows for such advancement (or retraction) by rotary to linear linkages between the knobs 106, 264 and the
5 respective pressure feet 86, 134 and associated pads.

As described above, the pad wear compensator includes inboard pressure foot or inboard indicator 86 which is threadably engaged with the sidewall of the inside cylinder. Rotation of the inner knob 106 in a clockwise direction advances the pressure foot within the cylinder and therefore the pad assembly along the advancement axis as illustrated in Fig. 6.
10 As the pressure foot is advanced, the trailing end or indicator dog 96 received in the axial hole 110 of the inside knob 106 advances, to provide both a visual and tactile indication of the amount the pressure foot has advanced within the inside cylinder. In addition, the radially outwardly extending detents 124 of the inside indexing spring clip 116 engage with equally
15 circumferentially spaced knurls 126 in the inner diameter of the flange 125 to provide a tactile indication of movement of the knob. The knurls 126 and radially outwardly extending detents 124 are spaced so that each engagement between the detents and sockets indicates a uniform linear distance of advancement of the pad toward the disc. For example, in the preferred embodiment, each tactile click equates to 1/16 of a full rotation and 1/16 of a millimeter of pad advancement. The inboard pad assembly is retracted by rotating the inside knob counter-
20 clockwise.

The outboard pad wear compensation apparatus 153 relies on a similar rotary to linear linkage as the inboard pad compensator 73, but it is slightly more complicated. Rotation of the outside knob 264 in a clockwise direction in turn causes rotation of the indicator foot screw 148 in a clockwise direction. This rotation threadably advances the indicator foot screw
25 148 relative to the drive cam 158 which in turn advances the ball bearing 146, the outside pressure foot 134 and the corresponding first brake pad assembly 72. The outside pressure foot in its advanced position is illustrated in Fig. 6. It should be noted that the split washer 141 received in the annular groove 140 causes friction between the outside pressure foot and

the fixed cam to prevent the outside pressure foot from simply sliding out of the outside cylinder. As with the inside knob, the outside knob also provides a tactile indication of rotation corresponding to a select linear advancement. This is provided by the inwardly extending detents 278, which engage with the indexing knurls 258 of the larger outer diameter washer 256. In addition, as described above, advancement of the indicator foot screw 148 and therefore the outside pressure foot 134 can be monitored visually and by feel by noting how far the trailing end 156 of the indicator foot screw 148 advances relative to the outer surface of the outer knob 264 within the axial hole 268. To retract the pad, the outside knob is rotated counter-clockwise to retract the indicator foot screw 148 and the drive mechanism is actuated to squeeze the disc, which in turn retracts the outside pad assembly 72 and the outside pressure foot 134 by forcing them into abutment with the retracted foot screw 148.

The pad wear compensating apparatus not only allows for convenient advancement of the brake pad assemblies as the brake pads wear, but the structure also provides a quick and convenient way to properly align the caliper housing 18 relative to a disc 14. This can be done by loosening the mounting bolts 28 and then advancing the pad assemblies into contact with the disc using the inboard and outboard pad wear compensators 73, 153. With the disc squeezed between the pads, the mounting structure including the slotted mounting feet 20, 22 and the concave and convex washers 30 enables precise alignment of the caliper housing to maintain the leading pad surfaces parallel to the disc. Tightening the mounting bolts 28, 30 then secures the precise alignment. For example, because the inner pad assembly is stationary, it is generally preferred to provide a very small clearance between the inner pad and the disc and a greater clearance between the moveable outer pad and the disc. This set up can be achieved by starting with the pads fully withdrawn along the advancement axis into the cavity 360 as shown in Fig. 5 and then advancing the inner pad assembly using the inner knob a short distance while advancing the pad associated with the outer knob a greater distance into contact with the disc. The mounting bolts are then tightened and the knobs are turned to retract the pad assemblies to provide a desired operative gap with the disc.

While this greatly simplifies the process of properly aligning the caliper housing and brake pads during initial set up, the pad advancement structure in combination with the caliper

housing mounting system also provide for simplified field repair. For example, if a user crashes and one of the attachment bosses is bent, the user can detach the mounting bolts 28, bend the bent attachment boss back in position as well as possible by eye-balling it and then reposition the caliper housing with the brake pads properly aligned parallel to the disc simply by repeating the procedure described in the preceding paragraph.

In operation, as the brake pads are caused to compress the disc therebetween, a high tensile force is applied to the housing in the vicinity of the inside and outside cylinders. This can put tremendous stress on the housing, and can even cause the housing to split apart. This problem is all the more acute where the housing is cast from a lightweight, relatively low tensile strength metal such as aluminum. To address this problem, the mechanical disc brake housing has a pair of threaded bores 400, 402, which extend the width of the housing on opposite sides of the pivot axis 46. A steel screw 404 threadably engages each threaded bore 400, 402 and is tightened to pre-stress or pretension the caliper housing. The screws are preferably tightened to apply a compression force of about 1,000-1,400 lbs. This not only prevents cracking and failure of the housing, it virtually eliminates any flexure of the housing that could dissipate braking power or fatigue the housing.

The mechanical disc brake caliper 10 also includes a mechanism for adjusting the return force on the lever arm 32 applied by the return spring 228. Referring to Fig. 9, adjustment screw 410 is threadably received in a threaded bore 412 in the housing which breaches the outer cylinder with the axis of the bore 412 aligned with the stop surface 224 of the spring tension biasing plate 220. As the adjustment screw 410 is advanced within the threaded bore 412, the spring tension biasing plate 220 rotates about the cylindrical body 180 of the fixed cam 178 to increase the tension on the spring. Turning the adjustment screw 410 to retract it from the bore causes rotation of the spring tension biasing plate 220 which decreases the tension on the spring 228. As seen in Fig. 9, the spring tension limiting slot 222 cooperates with the spring tension limiting boss 186 of the fixed cam 178 to limit rotation of the spring tension biasing plate 220 and therefore the range of return force applied to the lever arm 32.

It may be useful or desirable to provide a ball spacer between the drive cam 158 and the fixed cam 178 to maintain the ball bearings 176 equally spaced within the elongated ramped grooves 162, 200. If such a ball spacer is to be used, one embodiment of a design for such a ball spacer is illustrated in Figs. 25 and 26. The ball spacer 420 could be made of a simple sheet metal stamping consisting of a ring body 422 with inwardly extending radial leg pairs 424 spaced to correspond to the desired spacing of the ball bearings. The radial legs 424 can be curled as illustrated in Fig. 25 to define a ball receiving socket 426. The legs 424 of each pair are circumferentially spaced so that a ball bearing 176 can be snap fit therebetween as illustrated in Fig. 26. Figures 27 and 28 depict another embodiment of a ball spacer molded of plastic. Notches 427 in a ring 428 are sized to snap fit with the ball bearings 176. The ring is thick enough and the insides of the notch are slightly concave (see 429 in Fig. 27) to secure the ball bearing about an axis as illustrated in Fig. 28. Either ball spacer embodiment secures the ball bearings 176 about an axis and thus ensures that the ball bearings 176 will maintain an equal radial spacing and further ensures that the ball bearings will be the same distance between the face of the drive cam and the fixed cam.

The ramped groove structure of the fixed cam and drive cam illustrated in Figs. 4A and 4B is useful for most applications, but it limits the amount the lever arm can be rotated to, at most, slightly under 120°. An alternate ramp structure is depicted in Fig. 29. As illustrated in Fig. 29, the ramps 430 spiral inward as they ramp upward toward the leading surface 432. With such corresponding structures provided in the leading surface of the fixed cam and the drive cam, the ramped grooves 430 can be much greater in length and have a much more gradual incline. This will enable the associated lever arm 32 to rotate much greater than 120° and for the inboard brake pad to be advanced linearly at a slower rate as the lever arm 32 is pivoted.

The outer knob is shown in a perspective view in Fig. 19. The outer knob has an elongate slot 440 corresponding to each axially inwardly extending leg 270. Referring to Fig. 20, each elongate slot 440 overlies a corresponding barb 272. The holes 440 are formed during molding of the outer knob 264 by a mandrel which occupies the space that defines the hole 440, with the distal end of the mandrel contributing to the forming of the undercut of

the barb. In this manner, the undercuts are introduced to the knob while still enabling the knob to be injection molded in a single step. Referring to Figs. 21 and 22, the inner knob 106 likewise has elongate slots 442 corresponding to each inward axially extending leg 112. As with the outer knob described above, the slots overly the barbs 114 and enable formation of the undercut on the barbs by means of mandrels as described above with regard to the inner knob.

5

CLAIMS

1. A cable actuated mechanical disc brake caliper comprising:
2 a caliper housing;
a cable guide rigidly fixed to the housing, the cable guide having a cable receiving
4 bore extending along a guide axis for axially receiving a cable; and
a lever arm pivotably attached to the caliper housing for pivoting about a pivot axis,
6 the lever arm being operatively associated with a brake pad to move the brake pad between
a retracted and an extended position as the lever arm is pivoted in a first direction from a non-
8 actuated position to a fully actuated position, the lever arm including a cable clamp radially
spaced from the pivotal attachment for fixedly attaching a cable to the lever arm in a select
10 orientation relative to the lever arm at an attachment point, the attachment point being
essentially coincident with the guide axis with the cable arm in the fully actuated position.

2. The cable actuated mechanical disc brake caliper of claim 1 further
2 comprising:
a guide surface curved about the pivot axis having a first portion attached to the lever
4 arm with the attachment point essentially coincident therewith and a second portion
circumferentially spaced from the first portion, the second portion being essentially tangent
6 to the guide axis with the lever arm in the non-actuated position.

3. The cable actuated mechanical disc brake caliper of claim 2 wherein the curved
2 surface is concentric about the pivot axis.

4. The cable actuated mechanical disc brake caliper of claim 2 wherein the guide
2 axis remains tangent to the curved surface as the lever pivots.

5. The cable actuated mechanical disc brake caliper of claim 2 wherein the curved
2 surface is eccentric about the pivot axis.

6. The cable actuated mechanical disc brake caliper of claim 5 wherein the radius
2 of the curved surface increases between the first and second portions.

7. The cable actuated mechanical disc brake caliper of claim 5 wherein the radius
2 of the curved surface decreases between the first and second portions.

8. The cable actuated mechanical disc brake caliper of claim 1 wherein the cable
2 clamp clamps along an axis perpendicular to the pivot axis.

9. The cable actuated mechanical disc brake caliper of claim 2 wherein the curved
2 surface is formed by a horn attached to the lever arm at the first portion and the second
portion is a free end of the horn.

10. A cable actuated mechanical disc brake caliper comprising:
2 a caliper housing;
a cable guide rigidly fixed to the housing, the cable guide having a cable receiving
4 bore extending along a guide axis for axially receiving a cable;
a lever arm pivotably attached to the caliper housing for pivoting about a pivot axis,
6 the lever arm being operatively associated with a brake pad to move the brake pad between
a retracted and an extended position as the lever arm is pivoted in a first direction from a non-
8 actuated position to a fully actuated position, the lever arm including a cable clamp radially
spaced from the pivotal attachment for fixedly attaching a cable to the lever arm in a select
10 orientation relative to the lever arm at an attachment point; and
a guide surface curved about the pivot axis having a first portion attached to the lever
12 arm with the attachment point essentially coincident therewith and a second portion
circumferentially spaced from the first portion, the second portion being essentially tangent
14 to the guide axis with the lever arm in the non-actuated position.

11. The cable actuated mechanical disc brake caliper of claim 10 wherein the
2 curved surface is concentric about the pivot axis.

12. The cable actuated mechanical disc brake caliper of claim 10 wherein the guide
2 axis remains tangent to the curved surface as the lever pivots.

13. The cable actuated mechanical disc brake caliper of claim 10 wherein the
2 curved surface is eccentric about the pivot axis.

14. The cable actuated mechanical disc brake caliper of claim 13 wherein the
2 radius of the curved surface increases between the first and second portions.

15. The cable actuated mechanical disc brake caliper of claim 13 wherein the
2 radius of the curved surface decreases between the first and second portions.

16. The cable actuated mechanical disc brake caliper of claim 10 wherein the cable
2 clamp clamps along an axis perpendicular to the pivot axis.

17. The cable actuated mechanical disc brake caliper of claim 10 wherein the
2 curved surface is formed by a horn attached to the lever arm at the first portion and the second
portion is a free end of the horn.

18. A method of directing a cable to an lever arm of a cable actuated mechanical disc brake caliper wherein the lever arm is pivotably attached to a housing of the brake caliper for pivoting about a pivot axis and the lever arm is operatively associated with a brake pad to move the brake pad between a retracted and an extended position as the lever arm is pivoted in a first direction from a non-actuated position to a fully actuated position, the method comprising:
- providing a cable guide rigidly attached to the caliper housing defining a cable guide axis a select radial distance from the pivot axis;
 - feeding the cable through the cable guide;
 - attaching the cable to the lever arm at an attachment point about the select radial distance from the pivot axis; and
 - maintaining the cable essentially tangent to the guide axis as the lever is pivoted between the non-actuated and the actuated positions.

ABSTRACT

A cable actuated mechanical disc brake caliper includes a caliper housing and a cable guide rigidly fixed to the housing having a cable receiving bore extending along the guide axis for axially receiving a cable. A lever arm is pivotably attached to the caliper housing for pivoting about a pivot axis. The lever arm is operatively associated with the brake pad to move the brake pad between a retracted and an extended position as the lever arm is pivoted in the first direction from a non-actuated position to a fully actuated position. The lever arm has a cable clamp radially spaced from the pivotal attachment for fixedly attaching the cable to the lever arm in a select orientation relative to the lever arm and the attachment point. A guide surface is curved about the pivot axis and has a first portion attached to the lever arm with the attachment point essentially coincident therewith and a second portion circumferentially spaced from the first portion. The second portion is essentially tangent to the guide axis with the lever arm in the non-actuated position. A method of directing cable to a lever arm of a cable actuated mechanical disc brake described above includes providing a cable guide rigidly attached to the caliper housing defining a cable guide axis a select radial distance from the pivot axis and feeding the cable through the cable guide. The cable is attached to the lever arm at an attachment point about the select radial distance from the pivot axis. The cable is maintained essentially tangent to the guide axis as the lever is pivoted between the non-actuated and the actuated positions.

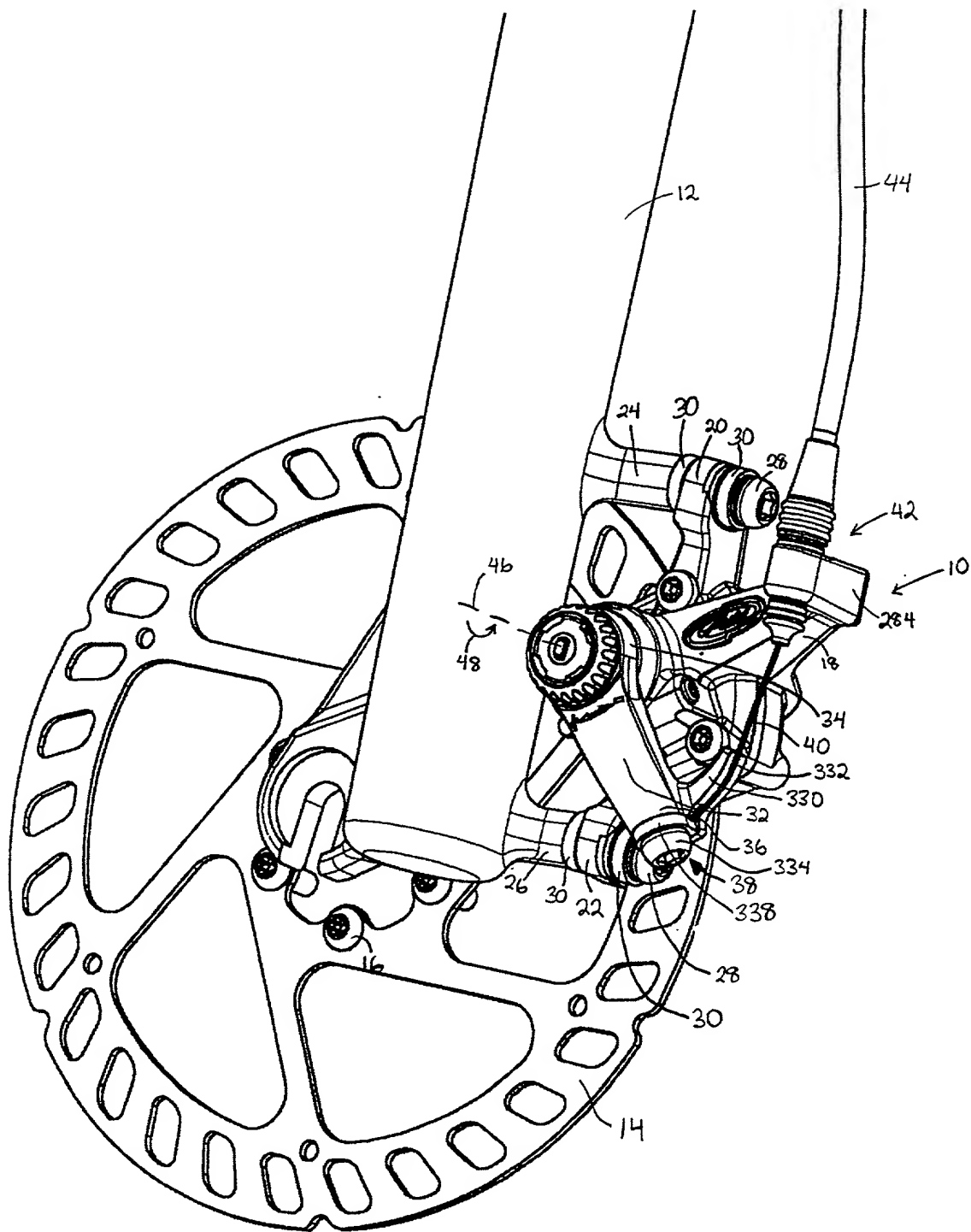


Fig. 1

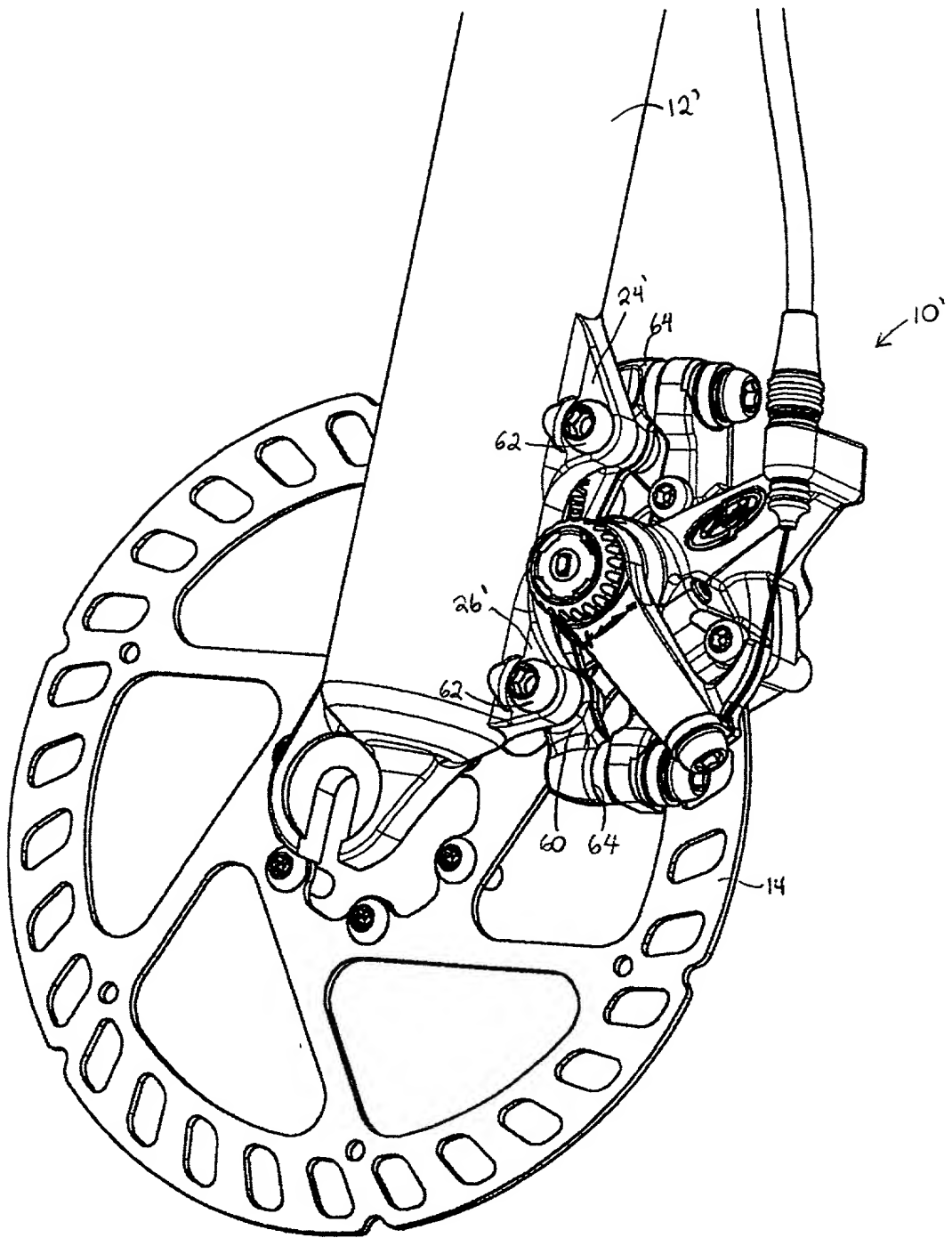


Fig. 2

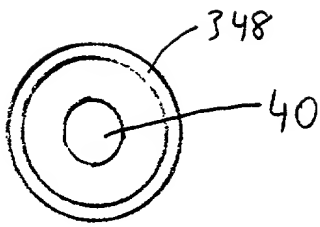


Fig. 3C

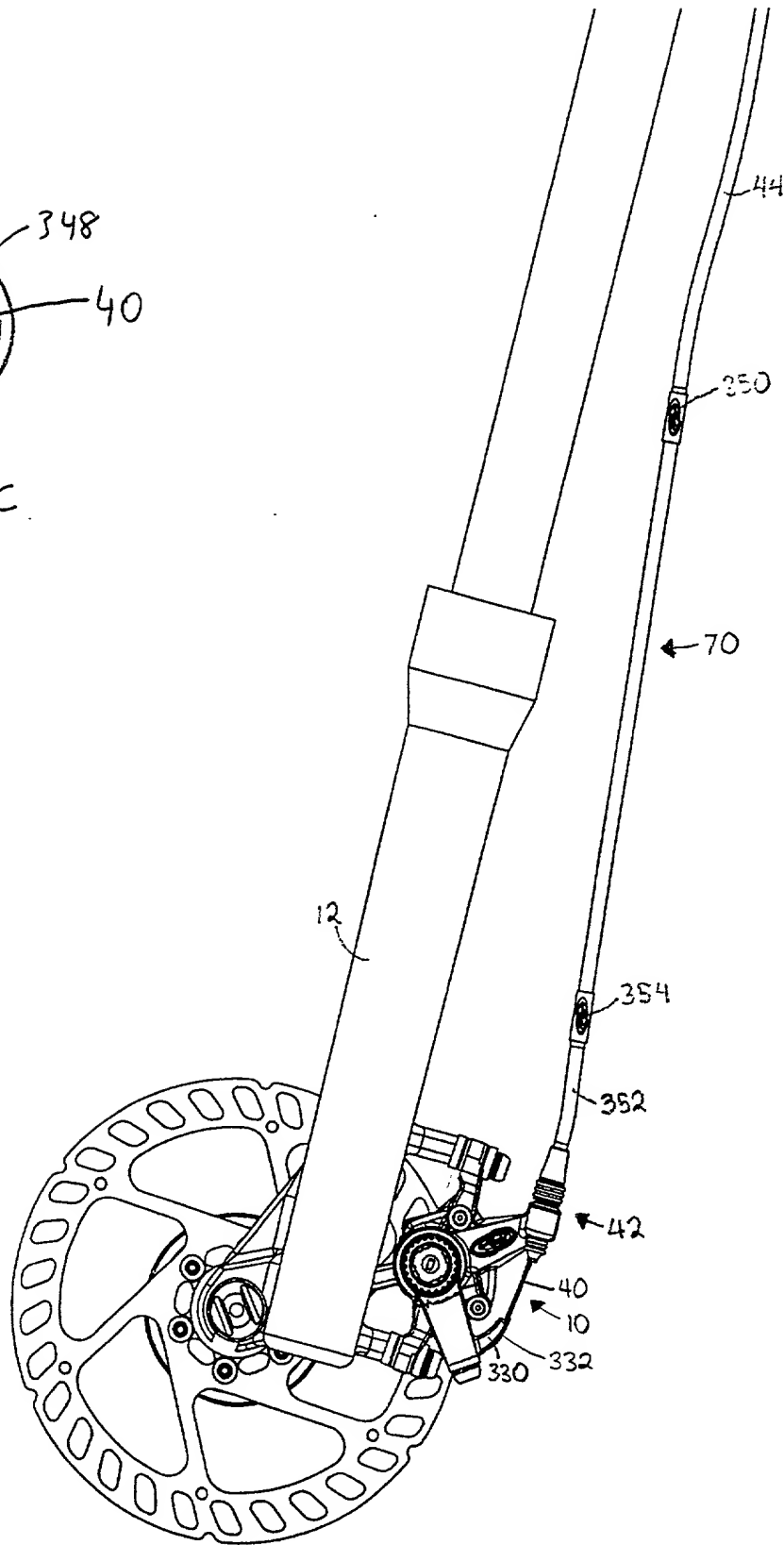


Fig. 3B

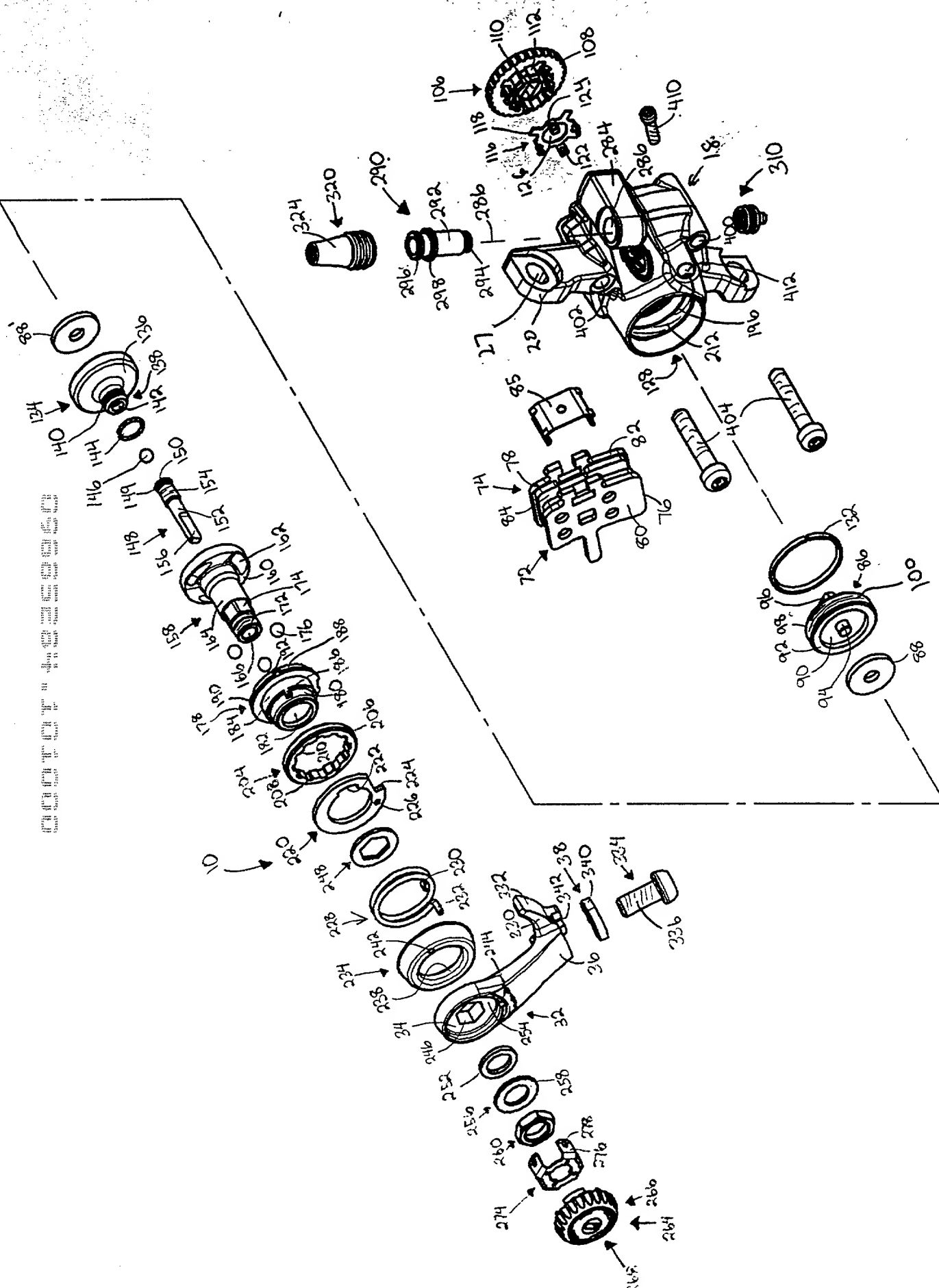


Fig. 4A

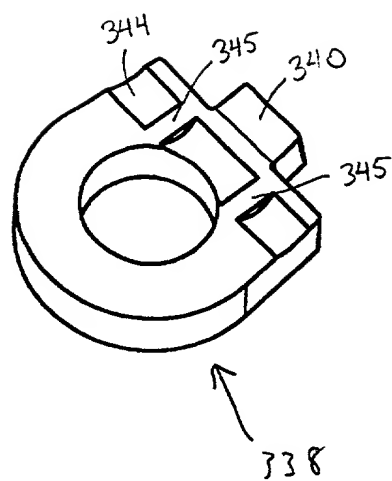


Fig. 4C

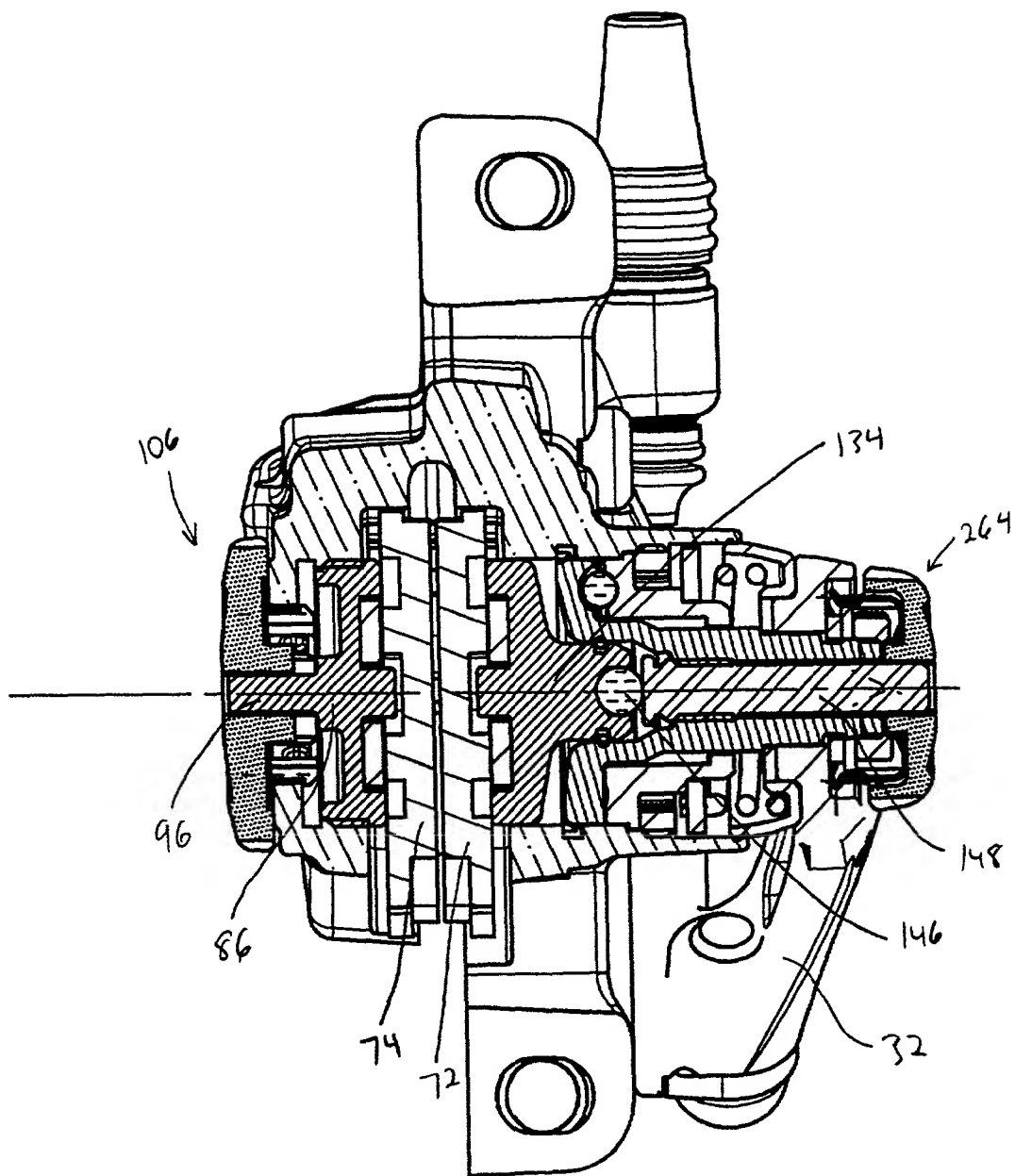


Fig. 6

FIG. 7 is a cross-sectional view of the device in a closed position, showing the internal components and the engagement of the locking mechanism.

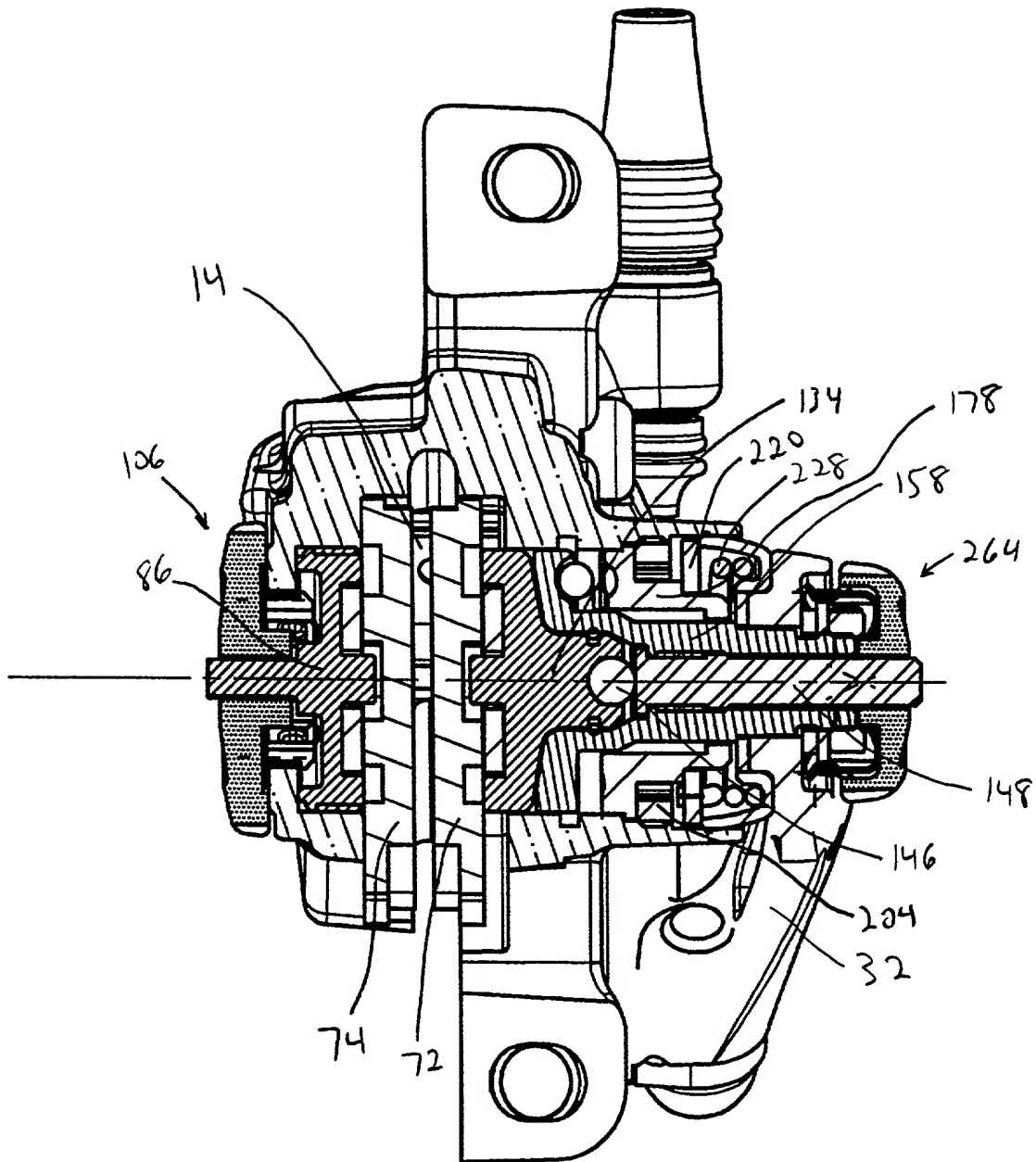


Fig. 7

FIG. 8 is a cross-sectional view of the device in a closed position, showing the internal components and the locking mechanism.

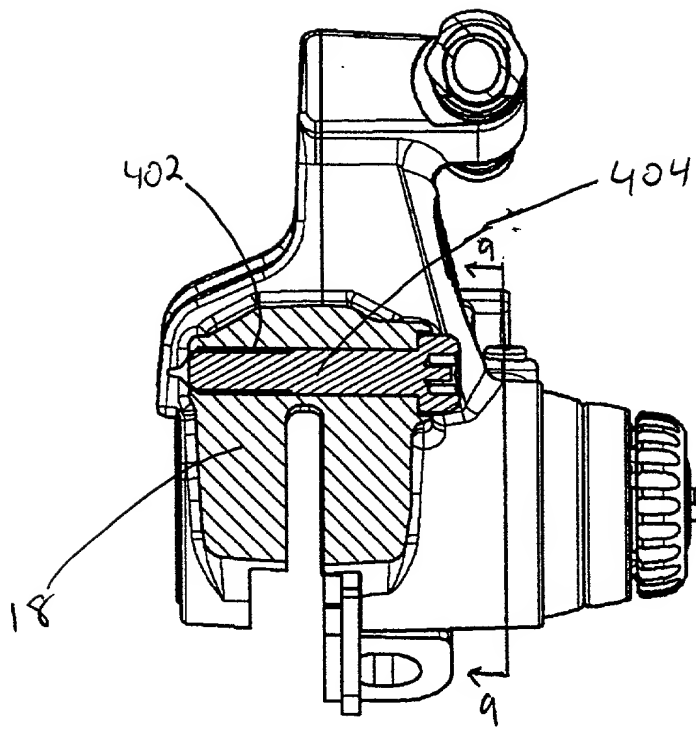


Fig. 8

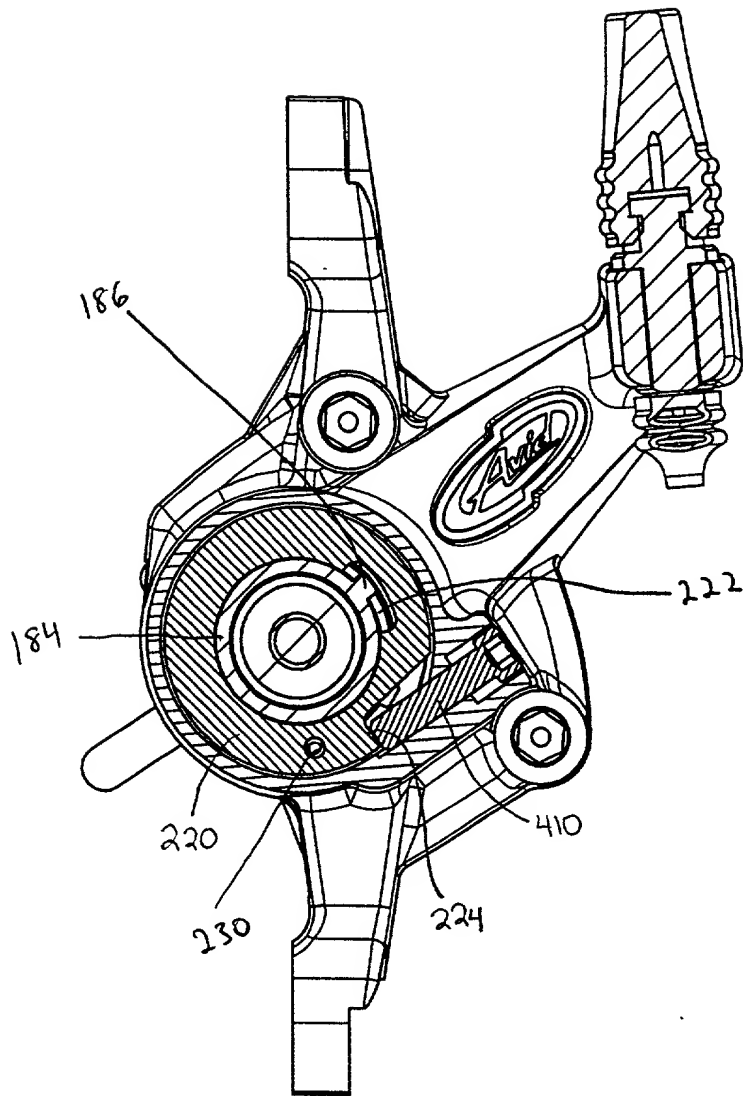


Fig. 9

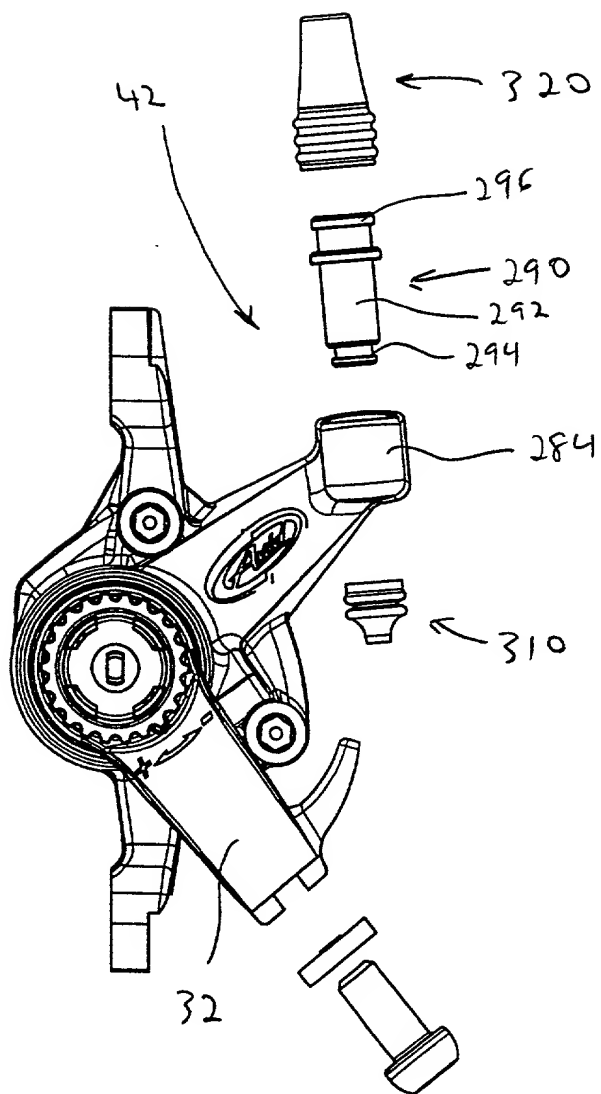


Fig. 13

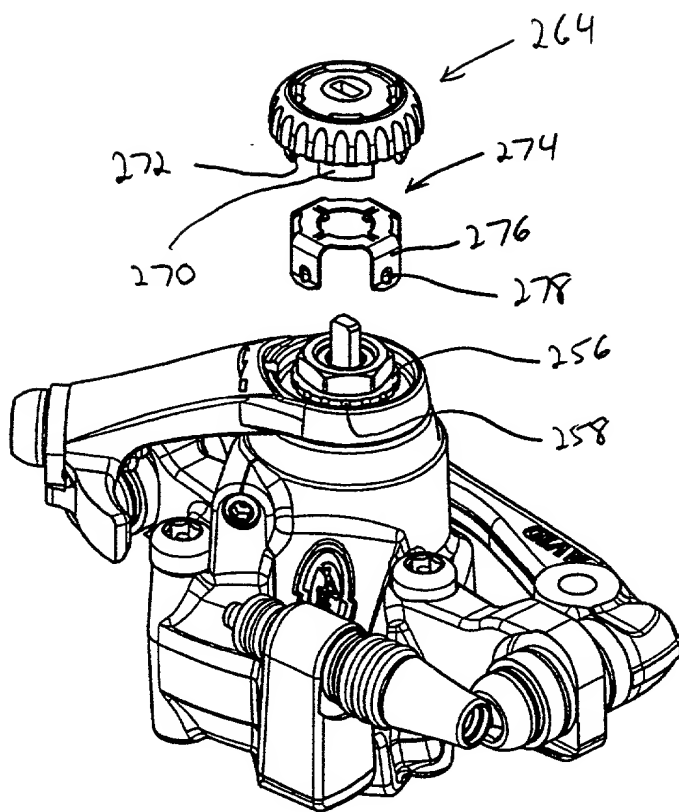


Fig. 14

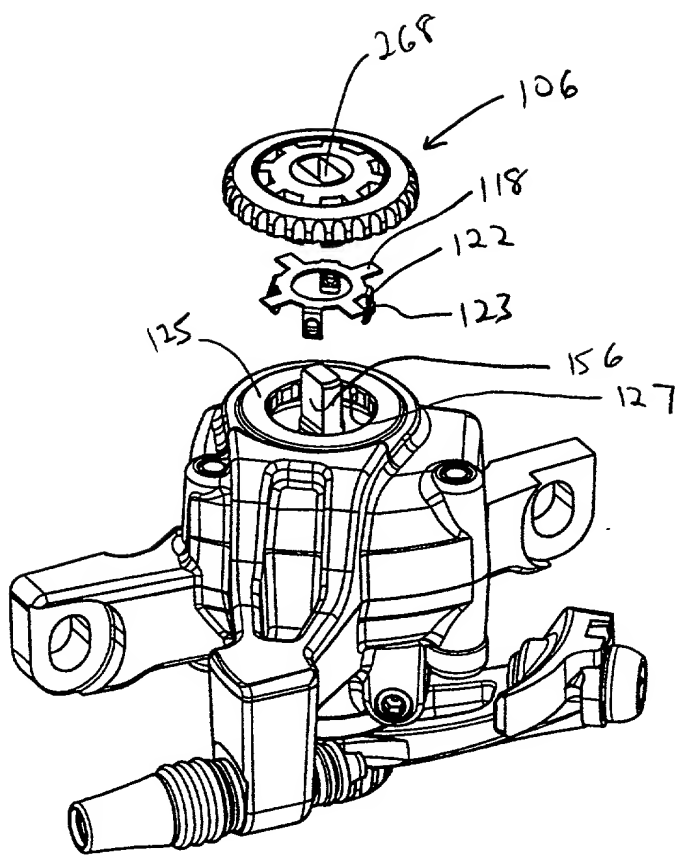


Fig. 15

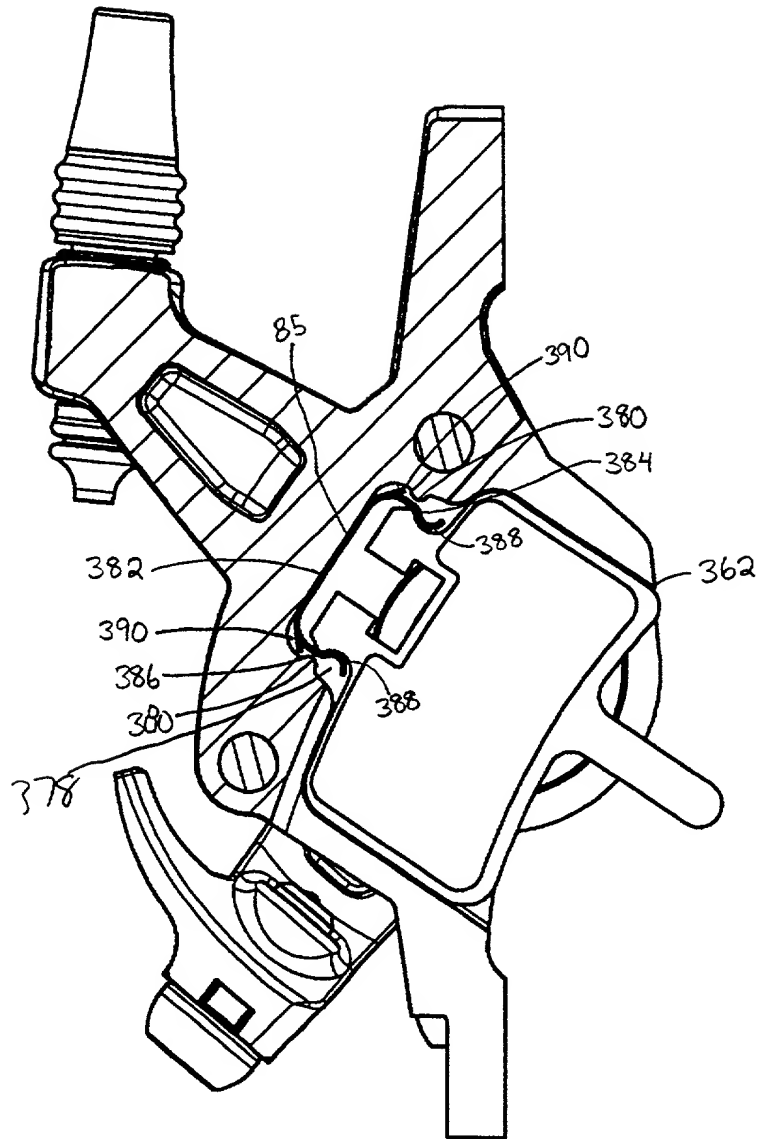


Fig. 16B

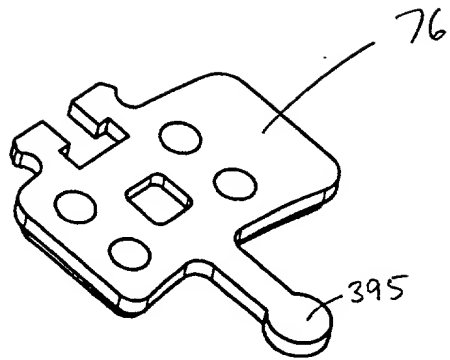


Fig. 17A

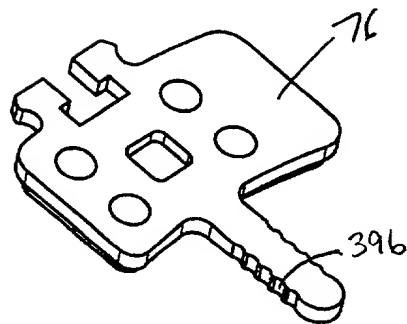


Fig. 17B

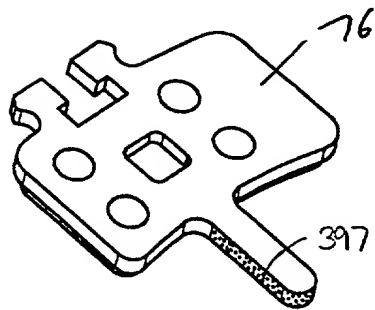


Fig. 17C

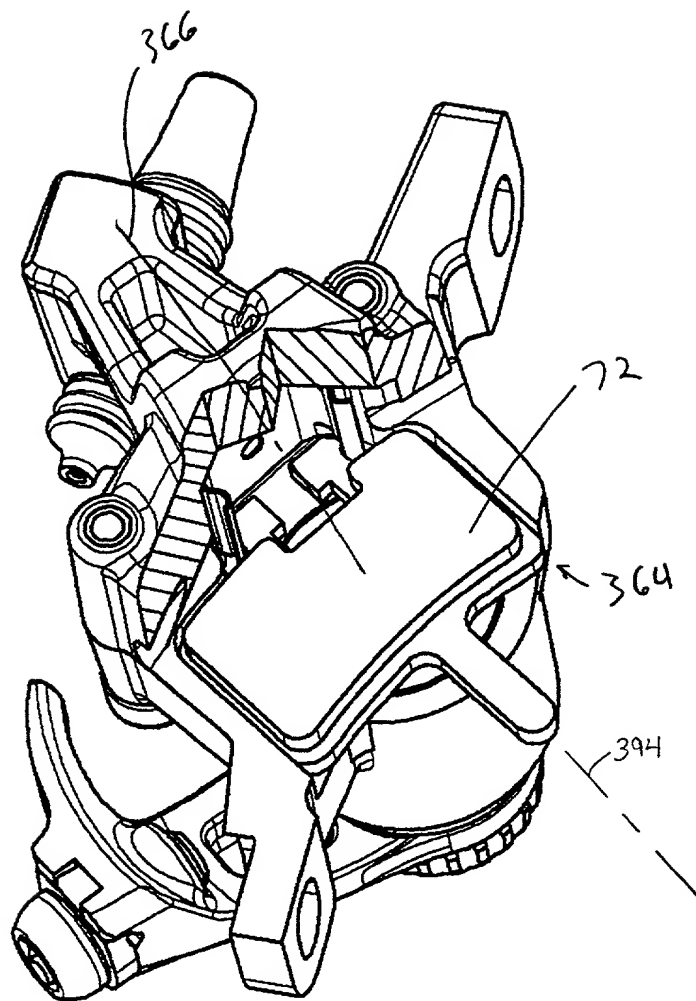


Fig. 18

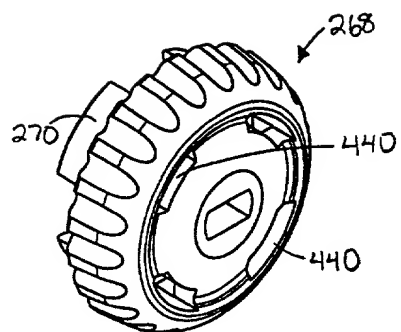


Fig. 19

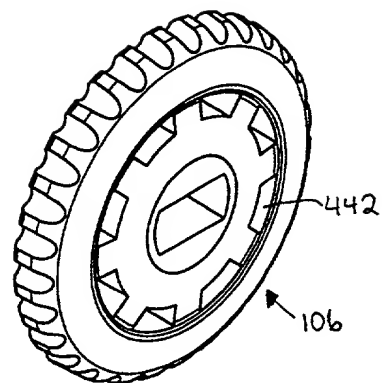


Fig. 21

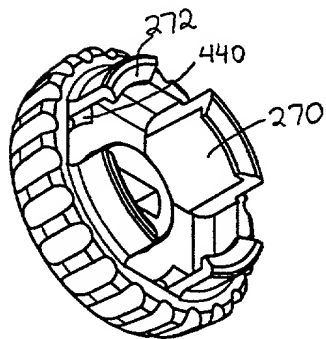


Fig. 20

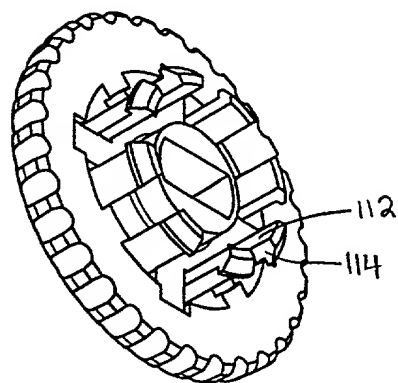


Fig. 22

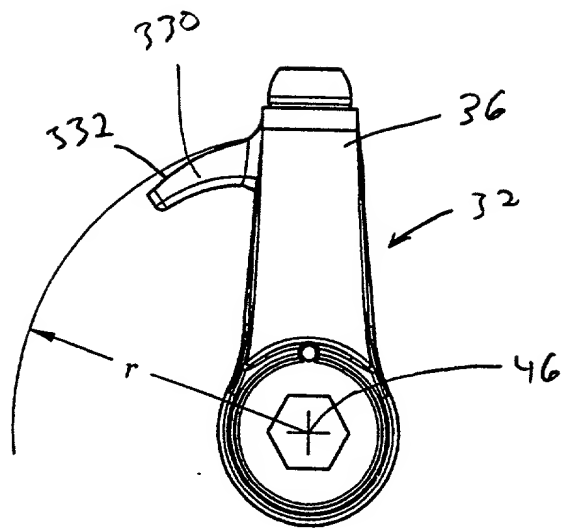


Fig. 23

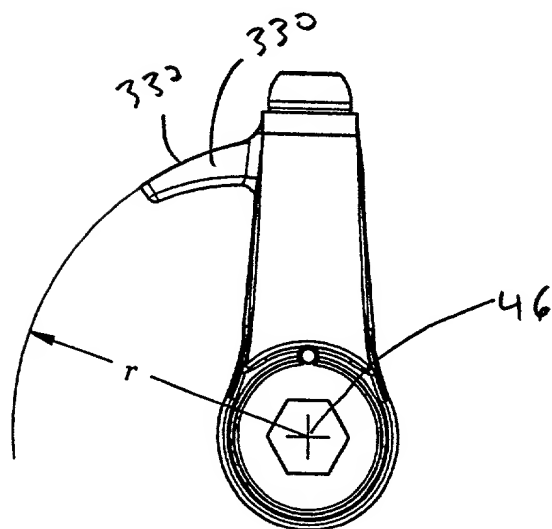


Fig. 24

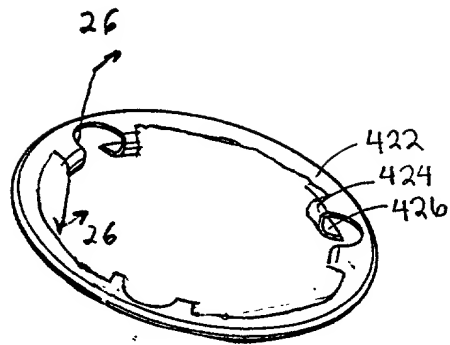


Fig. 25

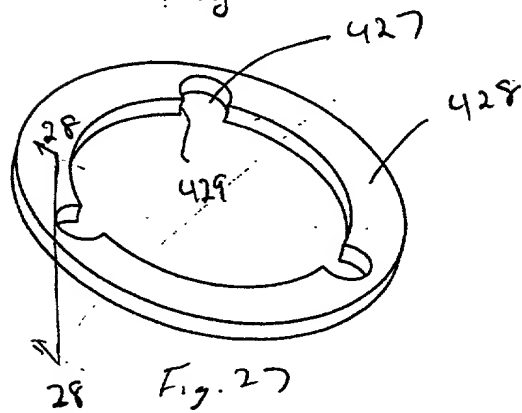


Fig. 27

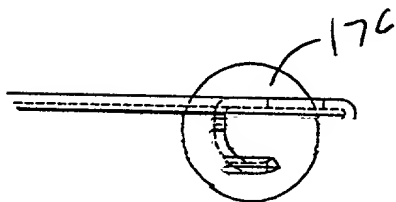


Fig. 26

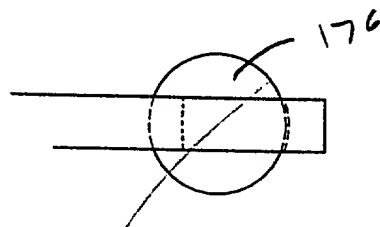


Fig. 28

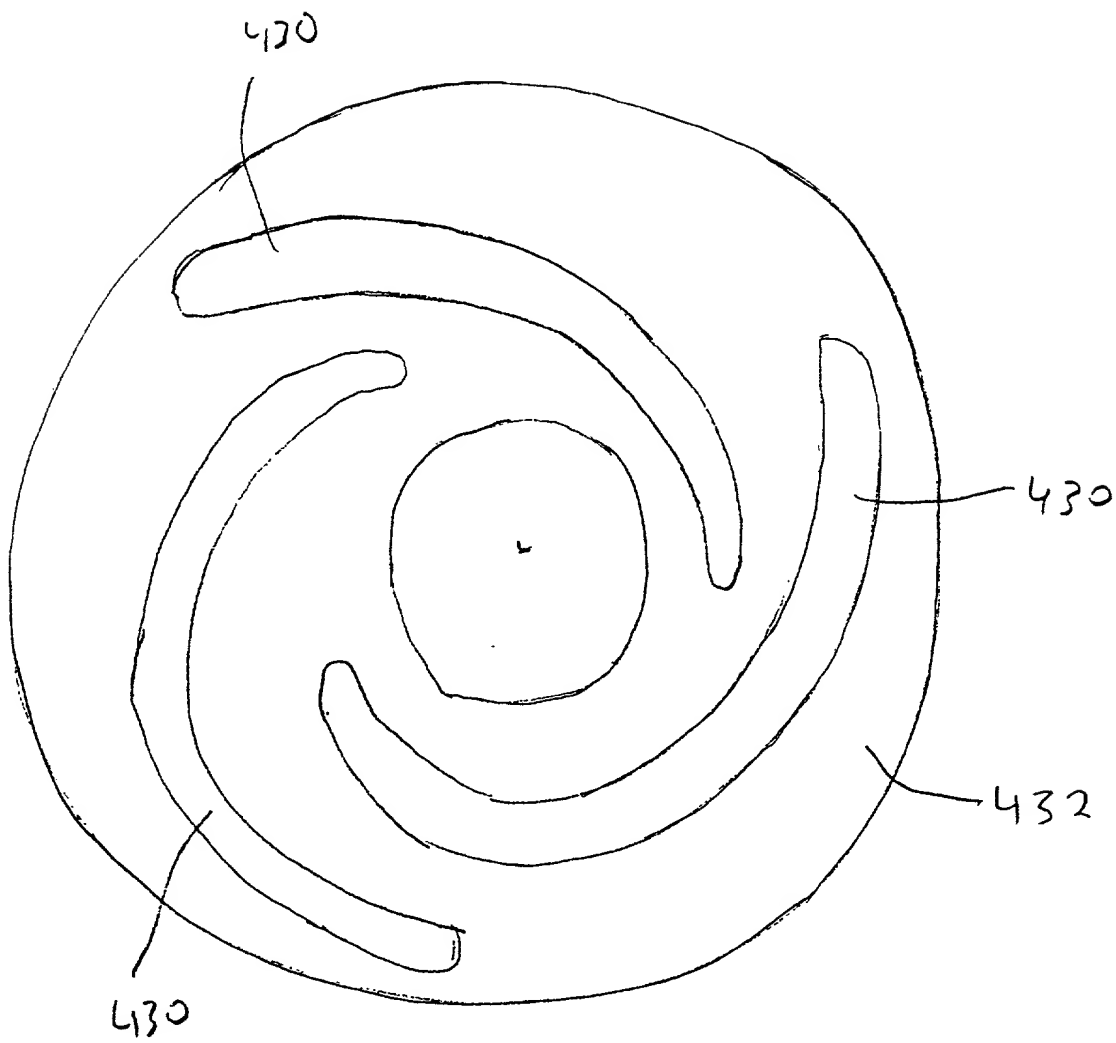


Fig. 29

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

Page 1 of 2

Docket No. AVID.13-2

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the sole, original and first inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled **Cable Feed for a Mechanical Ball Bearing Disc Brake**, the specification of which:

☒ is attached hereto.

☒ was filed on _____ as United States Application Serial No. _____ or PCT International Application Number and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR '1.56.

I hereby claim foreign priority benefits under 35 USC '119(a)-(d) or '365(b) of any foreign application(s) for patent or inventor's certificate, or '365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed. Prior Foreign Application(s)

Number: _____ Country: _____ Date Filed: (day/mo/yr) _____ Priority not claimed ☐

I hereby claim the benefit under 35 USC '119(e) of any United States provisional application(s) listed below.

Application Number: _____ Filing Date: (mo/day/yr) _____
60/195,560 04/06/00

I hereby claim the benefit under 35 USC '120 of any United States application(s), or '365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 USC '112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR '1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

Application Number: _____ Filing Date: (mo/day/yr) _____ Status - patented, pending, abandoned

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

Barry J. Swanson, #33,215
Thomas D. Bratschun, #32,966

Rosemary Kellogg, #39,726
Margaret M. Wall, #33,462

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Address all correspondence to: Thomas D. Bratschun
Swanson & Bratschun, L.L.C.
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Highlands Ranch, Colorado 80129

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 USC § 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor (given name, family name): Wayne R. Lumpkin

Inventor's signature: _____
Residence: Littleton, Colorado
Post Office Address: 7060 West Belmont Drive
Littleton, Colorado 80123

Date: 10-4-2000
Citizenship: US

☒ Additional inventors are being named on separately numbered sheets attached hereto.

Full name of second joint inventor (given name, family name): Michael T. Mayberry

Inventor's signature: _____

Residence:

Post Office Address:

Denver, Colorado,

1355 Adams Street

Denver, Colorado 80206

Date:

Citizenship: US

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